ISD Software Project Estimation

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Responsible Office: 580/Information Systems Division (ISD)
Title: ISD Software Project Estimation

Asset Type: Sub-process
PAL Number: 1.2.1

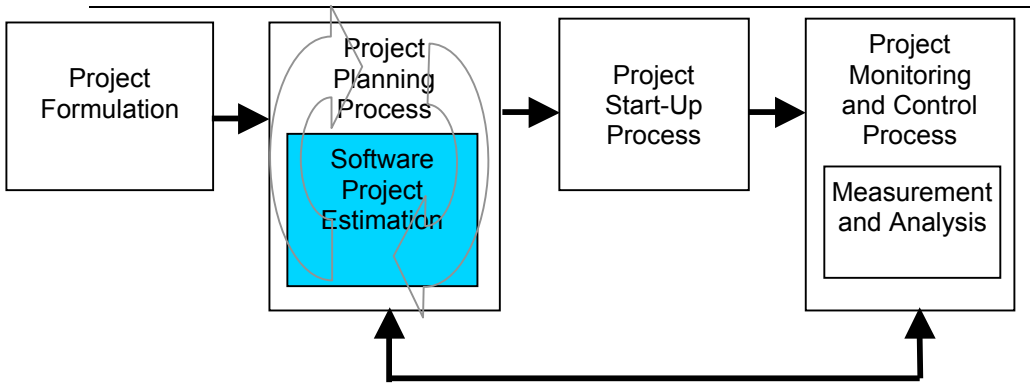
Purpose

The purpose of this sub-process is to help projects accurately and consistently estimate the size and complexity, effort, schedule, and cost of the software development project, and to document the basis of estimates (BOEs).

Scope

This sub-process operates within the Project Planning Process. It applies to the initial estimation performed during Project Planning, estimate updates at major milestones **and** to any re-planning that may be necessary. This sub-process is applicable to all ISD mission software projects.

Context Diagram



Roles and Responsibilities

Product Development Lead (PDL):
Conducts software project estimation and is responsible for the documentation of estimates.

Development Team Lead(s):
Supports the PDL in executing this process.

Usage Scenarios

This sub-process is entered from the Project Planning Process. There are three usage scenarios:

- Initial entry at inception of the software development or maintenance project
- Subsequent re-entry during next milestone update
- Subsequent re-entry during a re-plan

Inputs

While the following may still be under development, proceed with the best information available (and iterate/refine as more information is available) regarding:

- Requirements
- List of Deliverables
- Development/Acquisition Strategy
- A list of COTS, GOTS, and reused software components
- High Level Work Breakdown Structure (WBS)
- (For re-entry during re-planning) Risk Management Plan and Database
- Historical project data and personal experience
- Skills and experience levels required
- Full cost labor rates for skill types

Guidance: Input comes from Project Formulation, Project Planning, and Project Monitoring and Control Processes. The activities within the Project Planning process are iterative/interdependent and estimation activities may be "entered" multiple times. Also, input to estimation should be solicited from multiple Project Planning tasks. For example, input to estimation should be solicited from the "Identify Personnel and other Resources" and "Risk Identification and Planning" activities.

Entry Criteria

All inputs are required and one of the following:

- Initiation of development project or,
- Next milestone planning or,
- Identification of need to re-plan

Exit Criteria

All outputs are required and both of the following:

- Documentation of estimates and BOE
- Documentation of management approval

Output

Estimation Package (or Notebook) containing:

- Size estimates and BOE
- Effort estimate (including BOE and applied against schedule and WBS)
- Schedule estimate (including BOE)
- Cost estimate (including BOE and applied against schedule and WBS)
- Refined total life-cycle cost (including BOE)
- Actuals history for use in future estimation

Major Tasks

The PDL shall perform sequentially and iteratively (for the tasks 1-4) as necessary:

1. Estimate software size and document BOE
2. Estimate labor and document BOE
3. Estimate schedule and document BOE
4. Estimate costs and document BOE – ensure all cost information is held as proprietary
5. Finalize and approve estimates and BOE

GUIDANCE: The Development Team Leads have secondary responsibility

and support the PDL in each of the Major Tasks.

Task 1: **Estimate Software Size and Document the BOE**

a) Determine sizing estimation method. Typical methods of software estimation include:
   1. Count of subsystems or subroutines
   2. Analogous efforts
   3. Expert judgment (see "Wideband Delphi Estimation")
   4. Function point estimate
   5. Lines of code estimate

Guidance: There are trade-offs with each method of estimation. Select the method that provides adequate accuracy from appropriate time and effort. Other criteria such as number of pages in documents or numbers, classes / objects, volume of data, the number of displays / reports or number and complexity of functions may also be considered as appropriate. Consider the development of multiple independent estimates that are then reconciled.

b) Use the selected estimation method to estimate the size of the software to be developed

Guidance: The criteria/thought-process that justified/resulted in the estimate(s) is documented in the BOE. This basis should be developed with (or before) the actual estimate.

c) Determine the degree of uncertainty in the estimate, considering requirements completeness, stability, and risk of Technical Approach

Guidance: Uncertainty can be expressed descriptively (e.g., "rough", "ballpark", "firm", "high", or "low") or as a numeric proportion. This degree of uncertainty is necessary to understand the range of possible values and prepare appropriate reserves

d) Document all assumptions, estimates, uncertainty, and BOE

Task 2: **Estimate Labor and Document BOE**

a) Determine effort estimation method

b) Estimate effort taking into account the WBS, software size/complexity, and uncertainty.
   1. The estimates can be determined from various perspectives, including:
      a. Internal (Civil Servant) and external (contractor) labor
      b. Development, support, and operations labor
      c. Labor for work products
      d. Labor for WBS elements
   2. Methods of performing estimates includes:

a. Analogous efforts
b. Expert judgment (see "Wideband Delphi Estimation")

GUIDANCE: The branch and/or project may have specific procedures or desk instructions regarding the method for estimating effort.

c) Determine degree of uncertainty in estimates

d) Document the estimate, uncertainty, and BOE

Task 3: **Estimate Schedule and Document BOE**

a) Estimate total schedule duration
1. Methods of performing estimates includes:
   a. Analogous efforts
   b. Expert judgment (see "Wideband Delphi Estimation")

GUIDANCE: The branch and/or project may have specific procedures or desk instructions regarding the method for estimating effort.

b) Identify timing of life-cycle phases, major milestones, subsystems, configuration items and major activities

c) Develop schedule consistent with WBS

d) Document BOE

Task 4: **Estimate Costs in Dollars and document BOE**

a) Estimate labor costs taking size, complexity, effort, schedule and staffing profile (skill mix and staffing levels) into consideration.
1. Methods of performing estimates includes:
   a. Analogous efforts
   b. Expert judgment (see "Wideband Delphi Estimation")
2. Ensure the following are considered as appropriate:
   a. Internal (Civil Servant) labor
   b. Contractor labor
   c. Development and non-development (e.g., management and support, requirements management, CM) labor
   d. Operations Labor
   e. Labor for work products
   f. Labor for WBS elements

b) Estimate procurement and facilities costs which typically include:
1. COTS software
2. Hardware
3. Tools
4. Facilities (including tracking stations)

c) Estimate "other" costs which typically include:
   1. Other contract costs (e.g., award fees) – ensure all cost information is held as proprietary
   2. Development/test/operations/maintenance environments
   3. Travel

d) Determine/refine total life-cycle cost by year and quarter

e) Document BOE

Task 5:

Finalize and Approve Estimates and BOE

a) Distribute estimates to senior management and stakeholders for review, comment, and concurrence

b) Address comments as necessary

c) Document senior management approval

Guidance: The Software Manager and higher level management need to be aware of the degree of uncertainty in estimates and the software risks that could impact the Software Project. Responsibility for tracking risks – and appropriate reserves – must be negotiated and clearly defined. Feedback from this process may cause earlier tasks to be revisited resulting in updated estimates and BOE.

Measures

Recommended Measures:

- Actual effort spent on estimation

Tools and Templates

Name	Description
Software estimates / actuals database	Repository of baselined estimates and project actuals (TBD)
FSW Cost Estimation Spreadsheet/Guidelines	FSW costing tool with embedded guidelines (TBD)
FSW Complexities & Cost Comparisons Database	Database of actuals (TBD)
Point Counting Spreadsheets	Spreadsheets to support the monitoring of work that 1) have a moderate number of known tasks and 2) have task dependencies which are not a serious source of risk. The spreadsheets can display trend information to provide insight into progress including the ability to meet schedules.
System Evaluation and Estimation of Resources Software Estimation Model SEER SEM	GSFC has a site license of this tool that estimates software development and maintenance cost, effort, schedule, staffing, reliability and risk. It includes a knowledge base

	of algorithms to aid the in producing concept level estimates. SEER-SEM is sponsored by the Aeronautical Systems Center (ASC)/FME, Air Force Materiel Command (AFMC), and is currently used throughout the Department of Defense.
Ask Pete	An agency wide cost estimation and planning tool used at GSFC based on COCOMO II which provides: • Cost and schedule estimates • Recommended control level which should be used for the project • Recommended documents and plans which should be prepared during development • Descriptions of the typical activities that should be performed during each phase based on the identified control level • A schedule and estimate of Software Assurance activities • An evaluation of the likelihood and consequences of failure for a project and recommended IV&V and Independent Assessment activities. This system is customizable with the entire rulebase is stored in a Microsoft Access database which can be edited to delete, modify or add additional factors.
GiSMOW	A GSFC developed web-based ground system and mission operation cost estimating tool which covers the space to ground link and the mission operations portion of the ground system. Not a parametric cost model; instead it is intended to capture cost estimates performed for missions in the IMDC or missions in formulation. GiSMOW features: • A work breakdown structure that can be customized by the user • Mission milestones to ease the effort in updating a cost estimate due to schedule changes • Skill rates and inflation rates • Default/historic effort by activity curves or levels of effort • Reports of cost by quarter or year and by fixed dollars or real year dollars • Export of the cost estimate to Excel spreadsheets • Pre-built templates and sample missions • Built-in wizards

Training

Course Name	Description
Quantitative Software Management Class	Cost estimation topics covered include software estimating methods and models, software development estimation, software development metrics, cost drivers, productivity, common errors in software estimation, rules of thumb, software productivity databases, and risk reduction/mitigation.
Software Project Management	Week long project management class. Course ID HQ0005

References

- Cost and Schedule Estimating: NASA PAL Estimation page
- JPL Software Cost Estimation Handbook
- *FSW Estimation Procedure* (TBD)

- GPR-7120.1C: Program and Project Management
- GPR-8700.5A: In-House Development and Maintenance of Software Products

- 580-PG-8730.3.1: Product Development Handbook
- 580-PL-002-01**:** ISD Software Policies
- 580-PR-004-01: ISD Project Planning Process

- Wideband Delphi Estimation procedure
- Software Projects Lessons Learned
- Software Estimates/Actuals Database

- **Glossary:** http://software.gsfc.nasa.gov/glossary.cfm
  Defines common terms used in ISD processes
- **Process Asset Library:** http://software.gsfc.nasa.gov/process.cfm
  Library of all ISD process descriptions

Quality Management System Records

Controlled Document / Description	Record Custodian
Controlled Doc Name: Project Estimation Package	**PDL**

Change History

Version	Date	Description of Improvements
1.0	June 20, 2005	Initial approved version by CCB